NATIONAL AERONAUTICS AND SPACE ADMINISTRATION STANDARD POTTING AND MOLDING ELECTRICAL CABLE ASSEMBLY TERMINATIONS

John F. Kennedy Space Center

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JOHN F. KENNEDY SPACE CENTER

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STANDARD

POTTING AND MOLDING ELECTRICAL CABLE ASSEMBLY TERMINATIONS

1. PURPOSE

1.1 The purpose of this standard is to establish a standard process for potting and molding electrical cable assembly terminations using epoxy resin potting compositions and elastomeric dielectric compounds.

2. SCOPE

2.1 This standard describes the materials and methods to be used in potting and molding electrical cable assembly terminations with epoxy resin potting compositions and elastomeric dielectric compounds and the facilities and equipment required to perform the potting and molding processes. The standard dimensional requirements for potting and molding specific types of cable assemblies are specified in Appendix A.

3. REFERENCED DOCUMENTS

3.1 The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on the date of invitation for bids or request for proposals shall apply.

SPECIFICATIONS

Federal

O-T-634	Trichloroethylene, Technical.
TT-E-529	Enamel, Alkyd, Semi-Gloss.
TT-M-261	Methyl-Ethyl-Ketone (for Use in Organic Coatings).

George C. Marshall Space Flight Center

MSFC-SPEC-202	Compound, Potting and Molding, Elastomeric, Specification for.
MSFC-SPEC-222	Resin Compounds, Electrical and Environmental Insulation, Epoxy.

STANDARDS

Military

MIL-STD-171	Finish of Metal and Wood Surfaces.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with the application of this procedure should be obtained from the procuring activity or as directed by the contracting officer.)

4. DEFINITIONS AND ABBREVIATIONS

4.1 Definitions. - For the purpose of this standard, the following definitions shall apply:

(a) Abrade. - To remove gloss or roughen surface using sandpaper.

(b) Adapter. - The metal potting or molding ring which is attached to the rear of an electrical connector.

(c) Contamination. - The presence of impurities in compounds that are used for molding and potting.

(d) Durometer. - An instrument for measuring the relative hardness of a compound.

(e) Hot spots. - The concentration of heat in a small portion of a given area.

(f) Hygrometer. - An instrument for measuring the relative moisture (humidity) content of the air.

(g) Major cavity. - Consists of surface voids in excess of the "Minor Cavity" definition and within the qualifications of a repairable defect see 6.8.5.1.

(h) Minor cavity. - Consists of surface voids no greater than 1/8 inch in diameter and occuring no more than 5 per square inch.

(i) Molding. - Casting or injecting a liquid compound in, around, and throughout a part in which all parts of the can or mold are completely removed after the cure time.

(j) Potting. - Casting or injecting a liquid compound in, around, and throughout a part in which all parts of the form or mold remain with the finished part after cure.

(k) Sealant. - An elastomeric dielectric material used to prevent wicking at the ends of the cable.

(l) Wicking. - The absorption, by capillary action, of moisture or liquid into fibrous material used within cables.

4.2 Abbreviation. - For the purpose of this standard, the following abbreviations shall apply:

(a)	American wire gage	AWG
(b)	Celsius degree	°C
(c)	Fahrenheit degree	°F
(d)	Kennedy Space Center	KSC
(e)	Marshall Space Flight Center	MSFC
(f)	Methyl-ethyl-ketone	MEK
(g)	Polyvinylchloride	PVC
(h)	Pounds per square inch gage	psig

5. RESPONSIBILITIES

5.1 Design activity. - Each design activity of KSC shall be responsible for implementing the provisions of this standard. This standard shall be applicable to all phases of potting and molding electrical cable assembly terminations with epoxy resin potting compositions and elastomeric compounds.

5.2 Quality Assurance Division. - The Quality Assurance Division of KSC shall be responsible for assuring that the requirements of this standard are met.

6. PROCEDURES

6.1 Materials. - The following materials, substitutions, or deviations, as approved by the cognizant design activity, shall be used:

NOTE

Procuring agencies may obtain qualified products lists for Specifications MSFC-SPEC-202 and MSFC-SPEC-222 from the George C. Marshall Space Flight Center, National Aeronautics and Space Administration, Huntsville, Alabama 35812 Attn: MS-D.

6.1.1 Epoxy.

(a) Mold release. - The following, or approved equal, mold release compounds shall be used:

Material	Source
225 Mold Release	Ram Chemical Company
S-122 Fluorocarbon	Miller Stephenson Chemical Company
Vydax AR Telomer	E. I. DuPont DeNemours and Company

(b) Potting materials. - Potting compounds shall conform to the requirements of Specification MSFC-SPEC-222, Type II.

(c) Primers. - Primers shall be of the type recommended by the manufacturer of the material.

(d) Solvent cleaners. - Solvents used for cleaning purposes shall conform to the requirements of Specifications TT-M-261 and O-T-634, as applicable.

6.1.2 Elastomeric.

(a) MEK - The MEK solvent cleaner shall conform to Specification TT-M-261.

(b) Molding and potting compounds - Molding and potting compounds, conforming to Specification MSFC-SPEC-202, Type III (supplied as either two-part units or as a premixed, degassed compound frozen in cartridges) shall be used.

(c) Mold release - The following, or approved equal, mold release compounds shall be used:

Material	Source
225 Mold Release	Ram Chemical Company

(d) Primers - Primers, when required, shall be as specified in Specification MSFC-SPEC-202.

(e) Sealant - When required, the following repair and sealant material, or an approved equivalent, shall be used:

Material	Source
Pro-Seal 766	Coast Pro-Seal and Manufacturing Company
3C-900A Quick-Patch	Churchill Chemical Company

6.1.3 Storage life of materials.

6.1.3.1 Compounds and activators. - Storage life of compounds in original unopened containers and frozen cartridges, when applicable, shall conform to Specification MSFC-SPEC-202 (elastomeric) or Specification MSFC-SPEC-222 (epoxy).

6.1.3.2 Primers. - The storage life of primers may vary because of composition and shall be in accordance with the individual manufacturer's recommendations.

6.1.3.3 Containers. - All containers shall be labeled as to contents, before and after mixing, and shall show the pot life expiration date.

6.2 Configurations and dimensions. - Unless otherwise specified, configurations and dimensions shall be in accordance with the illustrations of Appendix A.

6.3 Equipment.

6.3.1 Vacuum chamber. - An evacuation system, consisting of a pump and a vacuum chamber capable of producing a minimum differential pressure of at least 29.5 inches of mercury, shall be used to minimize entrapment of air in the molding and potting materials.

NOTE

It is recommended that an integral mixer be used with the vacuum chamber to accommodate materials with a short pot life.

6.3.2 Mixing containers. - Mixing containers shall be of a nonporous material, such as metal, glass, or plastic.

6.3.3 Air pressurization equipment. - Air pressurization equipment shall be capable of delivering filtered air, having a maximum relative humidity of 5 percent, at a minimum pressure of 5 psig and a maximum pressure of 90 psig with sufficient capacity and pressure control to permit operation anywhere within this range.

6.3.4 Brushes. - Brushes shall have nonmetallic bristles.

6.3.5 Weighing equipment. - Weighing equipment shall include a gram balance and a pound balance. The gram balance shall have a 250 gram weighing capacity and shall be accurate to 1.0 gram. The pound balance shall have a 30 pound weighing capacity and shall be accurate to 0.1 pound.

6.3.6 Holding rack. - A holding rack, having a laboratory-type "Flexaframe" or similar parts fitted with holding clamps, shall be constructed to hold the cable components rigid and in proper alignment.

6.3.7 Injection gun. - A manual, semiautomatic or automatic powered semco, or approved equal, caulking gun shall be used for injecting the potting compound into the connectors. When using potting compounds specified in this standard, disposable polyethylene nozzles, plungers, and liners are required for the caulking gun. The gun capacity and nozzle size shall depend on the quantity and type of connectors being potted or molded. Extra care shall be taken to provide air gun with adequate isolation between the pressurized air and compound to avoid aeration of the mixture.

6.3.8 Cable molds. - Cable molds shall be easy to assemble, impervious to temperature change, strong and solid in construction, and easy to remove after the molding material has set.

6.3.9 Thermometer. - The thermometer shall be an immersion type, Fisher Scientific Company catalog number 14-995, or an approved equal.

6.3.10 Abrasive paper. - The abrasive paper shall be Minnesota Mining and Manufacturing Company's number 40 to 60 grit, or an approved equal.

6.3.11 Metal spatula. - The spatula shall be E. H. Sargent Company's Model S-75245, or an approved equal.

6.3.12 Hot plate. - The hot plate shall be E. H. Sargent Company's Model S-41075, or an approved equal.

6.3.13 Curing apparatus. - The molding and potting facility shall be equipped with approved curing apparatus. The curing apparatus may be an air-circulating oven, infrared equipment, heater strips, or rods. The curing apparatus shall be capable of maintaining a curing temperature within ±10 °C (±18 °F) and shall provide a means for preventing hot spots during the curing process.

6.4 Facilities.

6.4.1 Molding and potting area. - The dimensions of an acceptable molding and potting area shall be governed by the volume of work load. The area shall be of sufficient size to permit proper processing of cables. The area shall contain sufficient equipment and supplies to prevent the need for an overlap of operations. Fire wall and ceiling ratings shall not be less than 3 hours, and any paint application should be of the fire-resistant type. The hazardous atmospheric characteristics warrant group D equipment and fixtures.

6.4.2 Ventilation. - The molding and potting facility shall be provided with adequate ventilation equipment to exhaust inside air to the outside and introduce sufficient fresh air into the air-conditioning system (see 6.4.3)to accommodate the volume of compounds, solvents, and primers being used per hour. Forced-fed, positive-pressure ventilation is necessary, where vapors are generated. Pressure inside the potting and molding facility shall be maintained at 1 to 2 inches of water. Vapors and foreign matter shall be exhausted away from, down, and to the outside to avoid inhalation by the operator. The responsible safety agency shall be consulted to determine proper ventilation in ratio to the quantity of material being used.

6.4.3 Environmental conditions. - The temperature of the molding and potting facility shall be maintained at 24 ±3 °C (75 ±5 °F), and a relative humidity shall be maintained at 50 ±5 percent. Automatic equipment shall be installed to maintain these conditions. These conditions shall be maintained throughout all areas where mixing or other handling of potting or molding materials are used, or where these materials pass after being opened or relieved of their protective packaging. Workroom lighting should provide 100 foot-candles normal, 75 foot-candles minimum at 30 inches above the floor.

6.4.4 Cleanliness. - The potting and molding facility shall be isolated from such contaminants as dust, metallic particles, water, oil, and grease. Bench tops shall be protected from spillage by disposable coverings, and floors shall be cleaned frequently. Cleaning agents, used within the facility, shall be as specified in 6.1.1 and the cleaning process shall be as specified in 6.5.1.1.2.

6.4.5 Health and safety precautions. - When carelessly handled, the chemicals, utilized for molding and potting, may cause severe physiological reactions. The chemicals involved are safe when properly handled by trained personnel and when the following precautions are carefully observed.

(a) Avoid ingestion and inhalation of vapors.

(b) Avoid contact of solvents, primers, and compounds with the skin. Special care shall be taken to prevent contact with open breaks on the skin. Skin areas which do become exposed shall be cleaned with an approved cleaner and then with a nonabrasive soap and clean water. Cleanser jars, bottles, tools, or containers shall be individually used by personnel.

(c) Eyes or mucous membrane accidentally contaminated shall be flushed with water and receive medical attention immediately.

(d) Water deluge or flushing sink and eye wash fountain shall be provided in juxtaposition to operations involving toxic and skin contaminate and inhalant materials.

(e) Protective clothing shall be changed regularly and, when soiled by potting and molding materials, shall be laundered prior to reuse.

(f) No smoking or flames shall be allowed within a room where compounds, primers, and solvents are being used. "NO SMOKING" and "NO FOOD, BEVERAGES, OR TOBACCO ALLOWED IN THIS AREA" signs shall be displayed in conspicuous places. Before smoking or eating outside facility, personnel shall thoroughly clean exposed skin areas.

(g) An emergency shower or eye wash fountain combination shall be provided immediately outside the facility room.

(h) Exits should be unobstructed from any point or area. Panic hardware shall be provided inside of exit doors.

(i) Solvents, potting and molding compounds, and other flammables shall be stored only in ventilated metal cabinets or containers. Appropriate fire extinguishers shall be provided at 30-foot intervals throughout the facility.

NOTE

Supervisors shall conduct periodic inspections of the operator personnel for physiological reactions, such as itching rashes, blisters, cracks, defatted areas, and any dermatitis symptoms. Personnel exhibiting any physiological reaction shall be removed from contact with plastic and rubber chemicals until they are approved for continuance by the applicable medical office.

6.4.6 Inspection. - Facilities will be subjected to inspection for compliance with the requirements of this procedure by an authorized procuring agency representative.

6.4.7 Personnel. - Training, schooling, and certification of supervisory inspection, production, and repair personnel engaged in potting, molding, and mold making shall be consistent with the requirements of the KSC Quality Assurance Division.

6.5 Preparation of cable assemblies. - Prior to potting or molding, the cable assemblies shall pass an inspection for materials, workmanship, electrical continuity, short circuits, and isolation as specified by design documents. In all cases of shielding, bonding, and grounding, the applicable specification and design requirements for electrical configuration shall govern. All potting applications shall be coordinated with, and shall conform to, the basic electrical requirements for both shielded and unshielded cables.

6.5.1 General. - In preparation of cable assemblies, the following items shall apply, as applicable.

6.5.1.1 Adhesion.

6.5.1.1.1 Pretest. - Pretest (see 6.5.3 and 6.5.3.1) all conductor jacket and sheath material to assure that proper adherence with polyurethane can be achieved. When any of the insulation, jacket, or sheath material will not adhere properly, neoprene heat-shrinkable tubing may be used, upon approval of design activity, where this material would be in contact with the polyurethane.

6.5.1.1.2 Cleaning. - To ensure proper adhesion of the potting compound to all components of the connector, the inner body of the connector, wires, boot, and all other materials that will contact the compound must be clean and free of any trace of grease, oil, wax, or other contaminants. Any contaminated surface shall be cleaned by using a small, stiff-bristled brush and MEK, trichloroethylene, or other approved solvent.

CAUTION

Do not expose wire insulation to the cleaning solvent beyond the time required for adequate cleaning.

CAUTION

MEK shall not be stored in or used from an open container. Only containers approved by the responsible safety agency shall be used.

6.5.1.2 Potting or molding over epoxy. - When potting or molding over epoxy, abrade, break sharp edges, clean, and prime epoxy surface outside of conductor bundle (see 6.5.2.3 and 6.5.2.4).

6.5.2 Preparation of connectors.

6.5.2.1 Protection caps. - Protection caps shall be used at all times, including shipment, except during processes requiring mating connectors.

6.5.2.2 Mating connectors. - Mating connectors shall be used prior to pouring and until potting cures to prevent misalignment or creepage. Mating connectors are used for jigs and test purposes and are not part of cable assemblies. After mating connectors, back off coupling nut sufficiently to decompress insert materials. Salvaged connectors may be used for mating if pins, sockets, or other mating parts are not damaged.

6.5.2.3 Abrade. - Mask or otherwise protect conductors and finish of connectors and adapters in areas not specified to be abraded during the abrasion operation. Roughen (abrade) surfaces of rear of connectors that will contact potting or molding materials with sandpaper or other approved materials to remove slick surfaces. Carefully remove all grit from assembly. Clean, with approved solvent, all connector threads and coupling nuts to remove all grease, lubricants, and foreign matter. Abrade rear threads of connector and threads of metal potting-molding adapter (where used) with sandpaper or other approved material, so that the smooth surface is removed. Do not abrade connector-front mating threads or mating threads of coupling nut or any surfaces that do not contact potting or molding materials except connector adapter interfaces. Abrade, prime flat butt surfaces of connectors, where applicable, to assure adhesion of polyurethane. This process is required for general purpose Miniature 07, BFR, and Heavy Duty BFR type connectors and shall apply for similar type connectors.

6.5.2.4 Priming. - On surfaces that will contact potting or molding compound, check for cleanliness and prime with primer supplied by manufacturer of compound to be used and apply in accordance with manufacturer's instructions. Check rear connection threads and mating thread areas of adapter for cleanliness; prime with Loc-Tite Corporation's "Loc Quic Primer," or approved equal; coat with thread seize compound Loc-Tite Corporation's "Retaining Compound," or equal.

6.5.2.5 Assembly. - Perform the following steps, as applicable:

NOTE

Molding adapter for heavy duty connectors shall have eight holes approximately 45 degrees apart. Holes may vary in size depending on diameter of the molding adapter. Use approximately 1/8-inch diameter holes for 40 shell size adapters. Location of holes shall be as indicated on figure 1. If eight holes exist in molding adapter, this note may be disregarded.

(a) Where adapters or plug hulls are used, assemble adapter to connector and tighten. Adapters that have no stops shall be tightened until stopped by end of threads or by binding against flange or boss of connector. Adapters tightened against coupling nuts shall be backed off until coupling nuts are free. Adapters tightened against stops shall have torque applied to the following valves. (Take care that vise, table, etc., are secure.)

Shell Size	Foot Pounds
6 thru 14	15 to 25
16 thru 24	30 to 40
28 thru 40	100 to 125

In any case where binding of coupling nuts occurs, torque requirements shall be ignored and adapters shall be backed off until coupling nuts are free. After tightening and applying torque, if adapters have set screws, tighten into rear threads of connectors. For number 40 shell size heavy duty connectors, adapters shall have 3/16-inch holes drilled through adapter and rear connector shell on opposite sides approximately midway of thread interface. Take care that drill is sleeved or otherwise prevented from reaching closer than 3/32 inch to contacts. Similar metal high sheer press fit pins shall be driven and peened so that pins protrude into contact area approximately 3/32 inch but in no case closer than 3/32 inch to a wire or contact. Driven surface of pins shall be flush with adapter outer surfaces.

(b) Where coupling nuts obstruct set screw or lock pins, coupling nuts shall have one 3/8-inch hole drilled through to allow access to screws or pins.

(c) Break exposed sharp edges.

(d) Protect all bared surfaces (set screws, press fit pins, holes, etc., that will be exposed after molding) in accordance with 4.3, 5.13.4, and 7.3 of Standard MIL-STD-171. Paint one coat of enamel in accordance with Specification TT-E-529. Color shall be similar to connector.

6.5.3 Preparation of cable. - Proper preparation of cable assemblies depends on the applicable molding or potting compound and primer for the sheath material to be used. To determine whether the sheath material is neoprene, PVC, or polyethlene, touch a hot soldering iron to a scrap portion of the sheath material. If the sheath is PVC, it will melt and string out. If it is neoprene, the immediate area touched will crack and harden. If it is polyethylene, it will melt but not string out.

6.5.3.1 Primer. - There are many types and formulations of neoprene, PVC, and polyethylene. The use of a primer may be necessary for some of these. To determine if a primer is required, the "rubber test specimen" and the "vinyl test specimen" test methods outlined in Specification MSFC-SPEC-202 shall be made on specimens of the neoprene or PVC in question. For polyethylene test production samples, see 6.5.3.5.

6.5.3.2 Wicking. - To prevent wicking from occurring during cable molding or potting operations using elastomeric compound where cable jacket (sheath) material is used, seal the cable jacket (sheath) terminations with an elastomeric dielectric sealant (see 6.1.2). The seal shall be made at the jacket (sheath) termination and sealant flow shall be directed around and through all conductors. The sealant shall not exceed 1/4 inch above termination into the jacket (sheath). The diameter of the seal shall not exceed the cable diameter, including the cable jacket (sheath), and the overall length shall be 3/4 inch maximum. The sealant shall be processed in accordance with the manufacturer's instructions.

6.5.3.3 Preparation of neoprene sheath. - Neoprene sheath cables shall be prepared as follows:

(a) Remove all grease, oil, wax, and other contaminants with MEK from the area to be covered by the molding or potting compound.

(b) The sheath shall be abraded 1/8 ±1/16 inch above the area to be covered with the molding compound.

(c) Clean the abraded area with a nonmetallic bristled brush.

(d) Wipe the abraded area with a clean cloth dampened with MEK, changing the wiping area of the cloth as it becomes soiled. Wipe the cable dry with a clean cloth or dry with a jet of clean, dry air. A disposable wiper, such as Kimwipes, type 900-L, manufactured by Kimberly-Clark Company, or an approved equal, may be used in lieu of the cloth.

(e) If a primer is required, prime the abraded sheath area with the correct primer for the approved compound. The primer shall be applied 1/16 ±1/32 inch above the area to be covered with the molding or potting compound. Allow to dry as instructed by the manufacturer.

6.5.3.4 Preparation PVC sheath. - PVC sheath cables shall be prepared as ollows:

(a) Brush or wipe the sheath, 1/8 ±1/16 inch above the area to be covered with the molding and potting compound, with uncontaminated MEK until the surface becomes tacky.

(b) If a primer is required, prime the tacky area with the correct primer for the approved compound. The primer shall be applied 1/16 ±1/32 inch above the prepared surface to be covered with the molding and potting compound. Allow to dry as instructed by the manufacturer.

NOTE

Do not abrade PVC.

6.5.3.5 Preparation of polyethylene sheath. - Before potting and molding of roduction cables, sample cables shall be made and tested as follows:

(a) Prepare sample cable assembly.

(1) Apply manufacturer's recommended primer according to manufacturer's instructions.

(2) Mold in accordance with this standard.

(3) After curing and cable assembly is at room temperature, the cable shall be flexed and tested for adhesion of the molding material to the cable sheath, in accordance with this standard.

(b) If satisfactory adhesion is not obtained, prepare a second sample cable assembly.

(1) Apply a length of neoprene or PVC shrink tubing over the end of the conductor insulation and cable sheath. Tubing

shall extend along the cable sheath approximately 1½ inches above the molded portion.

(2) Mold requirements shall be in accordance with this standard, as applicable.

(3) After curing and cable assembly is at room temperature, the cable shall be flexed and tested for adhesion, of the molding material to the cable sheath, in accordance with this standard.

(c) Production cables shall be made using the method providing the proper adhesion.

6.5.4 Potting setup. - Potting setup shall be as follows:

(a) Assemble the mating connector (see 6.5.2.2) to ensure proper contact alignment during potting. The mating connector shall remain in place until sufficient curing time has elapsed.

(b) Clamp the connector in an upright, level, and secure position to prevent any movement of the components. The wire or cable shall be clamped in a vertical position to avoid any strain on the terminal joints.

(c) The wire bundle shall be centered, with respect to the connector and potting boot. Bundling shall not cause conductors to impose lateral strain on terminals. Unless otherwise specified, lateral clearance to surface of potting boot shall be 1/16 inch minimum from all internal parts and end of sheath.

6.5.5 Mold preparation. - Molds shall be prepared as follows:

(a) Examine and clean all surfaces and vent ports prior to each use.

(b) Using a brush, clean cloth, or aerosol spray, apply approved mold release to all surfaces of the mold and dry in an oven at 65 ±5 °C (149 ±9 °F). Do not leave marks on the cavity surfaces. Polish, as necessary, to obtain a blemish-free surface.

NOTE

If a mold is being used for the first time, the above step (b) mold release application and drying procedure shall be performed twice.

6.5.6 Molding setup. - The mold shall be assembled as follows:

NOTE

Prior to potting or assembling into a mold, electrical connectors shall be inspected for coupling nut binding.

The coupling nut must rotate freely, as required for proper connector engagement.

(a) Examine the cable assembly and determine that preparation procedures for neoprene, PVC, or polyethylene, as applicable, are complete as outlined in 6.5.3.

(b) Examine the assembly for freedom from contamination and foreign particles.

(c) Unless otherwise specified, lateral clearance to surfaces of mold shall be 1/16 inch minimum from all internal parts and end of cable sheath.

(d) When inserting cable sheath into mold, the sheath should be pressed as far as possible toward connector to afford slack in conductors.

(e) Before assembly of mold halves, all requirements of configuration and dimensions should be fully checked against Appendix A and the design drawings as specified. Where configuration and dimensional requirements are hampered, consult cognizant design activity before molding.

(f) Assemble the two half sections of the mold around the cable assembly.

(g) Before tightening the clamping screws, examine the assembly for correct alignment and positioning of the cable and connector.

(h) Tighten the clamping screws by applying a maximum torque of 20-inch pounds.

(i) Clamp the assembled mold and cable in a vertical, level and secure position with the cable connector down. The cable shall be vertically clamped above the mold to maintain alignment.

(j) The mold shall be clamped to restrict movement while compound is injected.

6.6 Preparation of compounds.

6.6.1 Epoxy potting compounds. - Determine that the two-part material, resin and activator, has been successfully acceptance tested as specified in Specification MSFC-SPEC-222 and that the shelf life has not expired. Use the following steps in preparing the compound for application:

(a) Examine the contents of both parts for solidification.

(b) If either of the parts have thickened, solidified, or crystalized, heat the part to manufacturer's recommended temperature. When

heating, thermometer shall be used to determine the actual material temperature. Stirring is essential during heating to assure uniformity and to hasten the melting procedure. Allow both parts to cool in room ambient at 21 to 24 °C (70 to 75 °F) before mixing. Do not artifically cool the material.

(c) Place both parts (in the proper proportional ratios) in a clean, dry, nonporous container having at least four times the capacity as the volume of the combined parts. Blend the parts thoroughly by mechanical agitation or by stirring with a clean metal spatula. Avoid fast stirring that may entrap excessive air and reduce application life.

(d) Place the container in a vacuum chamber and apply a vacuum of at least 29.5 inches of mercury. Maintain vacuum until foaming subsides, but not more than 20 minutes.

(e) Transfer the mixed compound from the mixing container to the injection gun cartridge by carefully and slowly pouring the compound down the inside of the cartridge, using care not to entrap air, until the desired level in cartridge is reached. Put the plastic plunger in place and insert the cartridge into the gun.

6.6.2 Preparation of elastomeric compounds.

6.6.2.1 Liquid. - The liquid compound shall be two-part units, consisting of base resin and activator, and shall be prepared as follows:

(a) Determine that the material has been successfully acceptance tested as specified in Specification MSFC-SPEC-202 and that the shelf life has not expired.

CAUTION

Use premeasured kits as supplied by the manufacturer. Do not use broken or partially used kits.

(b) Examine the contents of the base resin and activator for solidification.

(c) If either of the parts have thickened, solidified, or crystallized, heat the part to manufacturer's recommended temperature. When heating, a thermometer shall be used to determine the actual material temperature. Stirring is essential during heating to assure uniformity and to hasten the melting procedure. Allow both parts to cool in room ambient at 21 to 24 °C (70 to 75 °F) before mixing. Do not artificially cool the material.

(d) Place the base resin and activator in a clean, dry, nonporous container having a least six times the volume of the combined parts. Blend the parts thoroughly by mechanical agitation or by stirring with a clean metal spatula. Avoid fast stirring that may entrap excessive air and reduce application life.

(e) Place the container in a vacuum chamber and apply a vacuum of at least 29.5 inches of mercury. Maintain the pressure until foaming subsides, but not more than 20 minutes.

NOTE

Do not degas the compound by use of a centrifuge.

(f) Transfer the degassed compound into the injection gun cartridge by flowing the compound down the inside of the cartridge using care not to entrap air.

(g) Place the plastic plunger in the cartridge next to the molding and potting material. Exercise care not to entrap air while inserting the plunger.

6.6.2.2 Thawing of premixed, frozen cartridges. - It is essential that the thawing time and temperature of the frozen cartridges be closely controlled to obtain sufficient application life. An increase in either thawing time or temperature will reduce application life, and a decrease in either thawing time or temperature will result in an incomplete thaw. The following steps shall be followed for thawing premixed, frozen cartridges:

(a) Remove the cartridge from storage and thaw for 30 minutes at 49 ±5 °C (120 ±9 °F).

NOTE

A heating block or controlled heat lamps may be used for thawing frozen cartridges. Other thawing methods may be used, upon approval, by the procuring agency.

(b) During the thawing process, the cartridge shall be maintained in an upright position, nozzle end down with cap plug in place, to prevent air from entering and becoming trapped within the compound.

(c) Completely thaw and check the plunger to make sure that no air is entrapped.

(d) When once thawed, premixed, frozen cartridges shall not be refrozen. The cartridges shall not be used after application life has expired.

6.7 Potting instructions. - Epoxy or elastomeric compound shall be used for potting as specified by the design activity. The following suggested potting techniques vary from shop to shop because of equipment, facilities, or experience of personnel.

6.7.1 Inspection. - Examine cable assembly and determine that preparation procedures, as applicable, are complete and that assembly is free of contamination and foreign particles.

6.7.2 Injection.

(a) The injection gun should have a cartridge of prepared compound inserted ready for use.

(b) Attach the injection gun to the air supply (see 6.3.3 and 6.3.7) using the applicable hose connection. Attach the correct size gun nozzle suitable for potting job and adjust air pressure for slow even flow of compound (approximately 10 to 15 psig).

(c) Test the injection gun for free and even flow of compound from nozzle.

(d) Prepare a hardness test sample by using a small container to make a "button" of the compound (approximately 1 inch in diameter by 3/4 inch in thickness). Cure according to the same schedule as the job from which it is taken.

(e) Carefully insert the nozzle tip near the bottom of the connector for flow of compound around terminals (see alternate step (f)). Set the compound flow evenly by keeping the nozzle tip at the swell level. Avoid air entrapment during flow operation.

(f) When necessary, a 1/4-inch access hole may be drilled in boot 1/4 inch above back edge of connector and nozzle tip inserted here. Tape hole when filling is complete.

(g) If the compound rises unevenly, reposition the nozzle to allow level distribution. When repositioning the nozzle, the flow of compound should be stopped. Lifting the nozzle while compound is flowing will cause folding and voids in the fill.

(h) Continue injection of the compound until boot is full or a predetermined level is attained. Allow the compound to settle for 5 minutes. This lets any entrapped air escape. When the compound settles, replenish to the required convex level.

(i) Cover exposed connections with compound.

(j) If no pressure injection gun is available, introduce the compound into the prepared connector by carefully hand pouring the compound down one side of the connector in such a manner as to allow the compound to flow between the wires and contacts, entrapping a minimum amount of air. Fill the connector to the predetermined level, allow to set for 5 minutes, then fill to the required convex level.

6.7.3 Curing. - Curing schedules shall be selected from those recommended by the manufacturer, with limitations as specified in the contract or purchase order for the compound. (Specification MSFC-SPEC-222 for epoxy or Specification MSFC-SPEC-202 for elastomeric compound.)

6.7.4 Inspection.

6.7.4.1 Connectors. - After curing, inspect pins for length and condition.

6.7.4.2 Potting. - The potted cable shall be inspected for hardness, general appearance, and quality of workmanship. The surfaces of the potted area shall be free from voids, blisters, tackiness, soft spots, cracks, lumps, or any defect indicative of low quality or poor workmanship. The hardness shall be determined by three readings of a Shore Durometer, or approved equivalent, using "D" scale for epoxy or "A" scale for elastomeric compound. The readings shall be made on the sample prepared in accordance with instructions contained in 6.7.2 (d). The hardness of the cured material shall conform to the approved products list hardness rating for each applicable listed product.

CAUTION

Inspection personnel shall use care in handling assemblies potted with epoxy resins. The rigid, sharp edges of the cured resins in contact with the cable sheath may cut, mar, or multilate the sheath material if the cable is forcefully handled.

6.7.5 Repair. - Rework or repair of individual defects shall be at the discretion of the procuring agency. Repairable or reworkable defects shall be limited to those capable of being repaired or reworked without affecting serviceability or leaving undesirable latent defects. After repair or rework, the assembly shall be inspected to determine conformance to 6.7.4.

6.8 Molding instructions. - The following suggested molding techniques may vary from shop to shop because of equipment, facilities,or experience of personnel.

6.8.1 Inspection. - Prior to molding, examine the setup and determine that preparation,in accordance with 6.5.6,has been made and is in order.

6.8.2 Injection.

(a) The injection gun should have a cartridge of prepared compound inserted and ready for use.

(b) Attach the injection gun to the air supply (see 6.3.7) using the applicable hose connection. Attach the correct size gun nozzle suitable for the molding job and adjust air pressure for slow even flow of compound (approximately 10 to 15 psig).

(c) Test the injection gun for free and even flow of compound from nozzle.

(d) Prepare a hardness test sample by using a small container to make a "button" of the compound (approximately 1 inch in diameter by 3/4 inch in thickness). Cure according to the same schedule as job from which it is taken.

(e) Place the nozzle of the loaded cartridge into the injection port or mold, maintaining the required pressure. Force the molding compounds slowly into the mold until the compound emerges from the vent holes.

(f) Slowly withdraw the gun nozzle from the injection port and maintain the required pressure on the gun to allow the injection port to be filled with compound. Plug the injection port and allow the compound to settle in the mold.

(g) Allow 15 to 20 minutes for settling, then inject additional compound into the mold until the compound is flowing from the vents. Slowly withdraw the gun nozzle from the injection port, maintaining the required pressure on the gun to allow the injection port to be filled with compound.

(h) Plug the injection port on the side of the mold.

6.8.3 Curing.

6.8.3.1 Curing schedule. - Curing schedules shall be selected as recommended by the manufacturer, except the limitation as specified in Specification MSFC-SPEC-202 shall govern maximum curing time.

6.8.3.2 Molded assembly. - The molded assembly shall be submitted for inspection only after the assembly has been fully cured and cooled to room temperature.

6.8.4 Inspection.

6.8.4.1 Inspection test. - The molded cable shall be inspected for hardness, general appearance, and quality of workmanship. The hardness shall be determined

by three readings on the sample prepared as specified in 6.8.2 (d) using a Shore Instrument Company, "A" scale durometer, or an approved equal. The hardness of the cured compound shall conform to the approved products list hardness rating for each applicable listed product. The molded or potted surfaces shall be free of surface bubbles, blisters, tackiness, gas pockets, and other defects.

NOTE

Some rejected assemblies may be used as test fixtures, emergency spares, or may otherwise be acceptable to the U. S. Government. Other rejected assemblies may possibly be reworked or used for mating purposes; therefore, potted or molded assemblies that have been disqualified or rejected shall not be destroyed until the cognizant design activity has been notified and discrepancies discussed with inspection representative.

6.8.4.2 Transparency. - When drawings specify clear or transparent molding, coloration or cloudiness is allowable. Degree of transparency shall be such that after curing, shield rings, conductors, and other internal details shall be visible under ordinary light (approximately 40-foot candles) to the unaided eye. Bubbles from trapped voids shall be permissible if not more than 1/8 inch in diameter and not closer than 1/16 inch to conductor terminations or mold outer surface. There shall be no more than five visible bubbles as described above, per cubic inch, in any one mold.

6.8.4.3 Adhesion. - After full cure and after the assembly has cooled to room temperature, the cable shall be flexed at the tapered molded portion five times to determine whether the material is securely bonded to the cable. In no instance shall undue force be applied in order to determine adhesion. A blunt probe made of wood or plastic shall be used to test the adhesion of the molding or potting compound to the electrical connector. Care shall be taken to avoid damage to the assembly during inspection. Separation of the material from the cable or connector shall be cause for rejection.

6.8.4.4 Connectors. - After curing, inspect pins for length and condition.

6.8.5 Repair.

6.8.5.1 Repairable defects. - Repairable defects shall consist of those defects capable of repair without affecting serviceability or without leaving undesirable latent effects as determined by the procuring agency. After repair, the assembly shall again be inspected to determine conformance to 6.8.4.1 and 6.8.4.4.

6.8.6 Rework procedure.

6.8.6.1 Minor cavity. - In situations where a minor cavity (see 4.1) defect is present on a molded surface, the following rework procedure is permissible:

(a) Determine that the rework surface is clean.

(b) Contaminants may be removed by wiping with MEK.

(c) Prepare approved patch compound in accordance with the manufacturer's instructions and fill the cavity with mixed compound.

(d) Position a sheet of polyethylene film, or the proper mold, over the filled cavity and tape securely in place, using heat-resistant pressure-sensitive tape or mold tightening screws.

(e) Cure according to the manufacturer's instructions.

(f) Remove tape and polyethylene film; or the mold.

6.8.6.2 Major cavities. - In situations where major cavity (see 4.1) defects are present on the molded surface, the following rework procedure is permissible.

NOTE

Where the cavity defects are present only in the taper portion of mold, confine the rework procedure to this taper portion of the mold only.

(a) Mask entire outside of the electrical connector with four or more tape wraps. Mask cable sheath immediately adjacent to the termination of the tapered portion of the cable molding with four or more tape wraps.

(b) Use a high speed electric tool, Dremel Moto Tool Model No. 2, or approved equal, equipped with Dremel Cutter No. HS-415, or approved equal, to remove a maximum of 0.100 ±0.0025 inch from the entire surface or taper only of the cable molding.

CAUTION

Extreme care must be exercised by the operator to avoid nicking or in any manner touching the cutter to the electrical connector or cable sheath.

(c) Clean the area to be repaired with a nonmetallic bristled brush or apply a jet of clean, dry air (90 psig maximum) to the area.

(d) Using an identical mold with which the original molding was accomplished, remold in accordance with 6.8.2.

(e) Curing shall be completed in accordance with 6.8.3.

6.8.7 Inspection. - All rework shall be inspected as outlined in 6.8.4 through 6.8.4.4.

7. REPORTS

7.1 Reports shall be as required by the procuring activity. Cable/ Connector, Inspection Check List Number KSC OT665 is available and recommended for use as applicable.

8. MODIFICATIONS

8.1 Any substitutions or deviations from this standard shall be made only with the approval of cognizant design activity. Submit all recommendations for document modification to John F. Kennedy Space Center; Launch Support Equipment Engineering Division.

Notice. - When KSC drawings, specifications, or other data are used for any purpose other than in connection with a definitely related KSC procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that KSC may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Custodian:

NASA - John F. Kennedy Space Center

Preparing activity:

John F. Kennedy Space Center;
Launch Support Equipment
Engineering Division

Appendix A

LIST OF ILLUSTRATIONS*

* These illustrations contain standard configurations for cable assembly terminations. Individual design sheets may be more detailed than these illustrations.

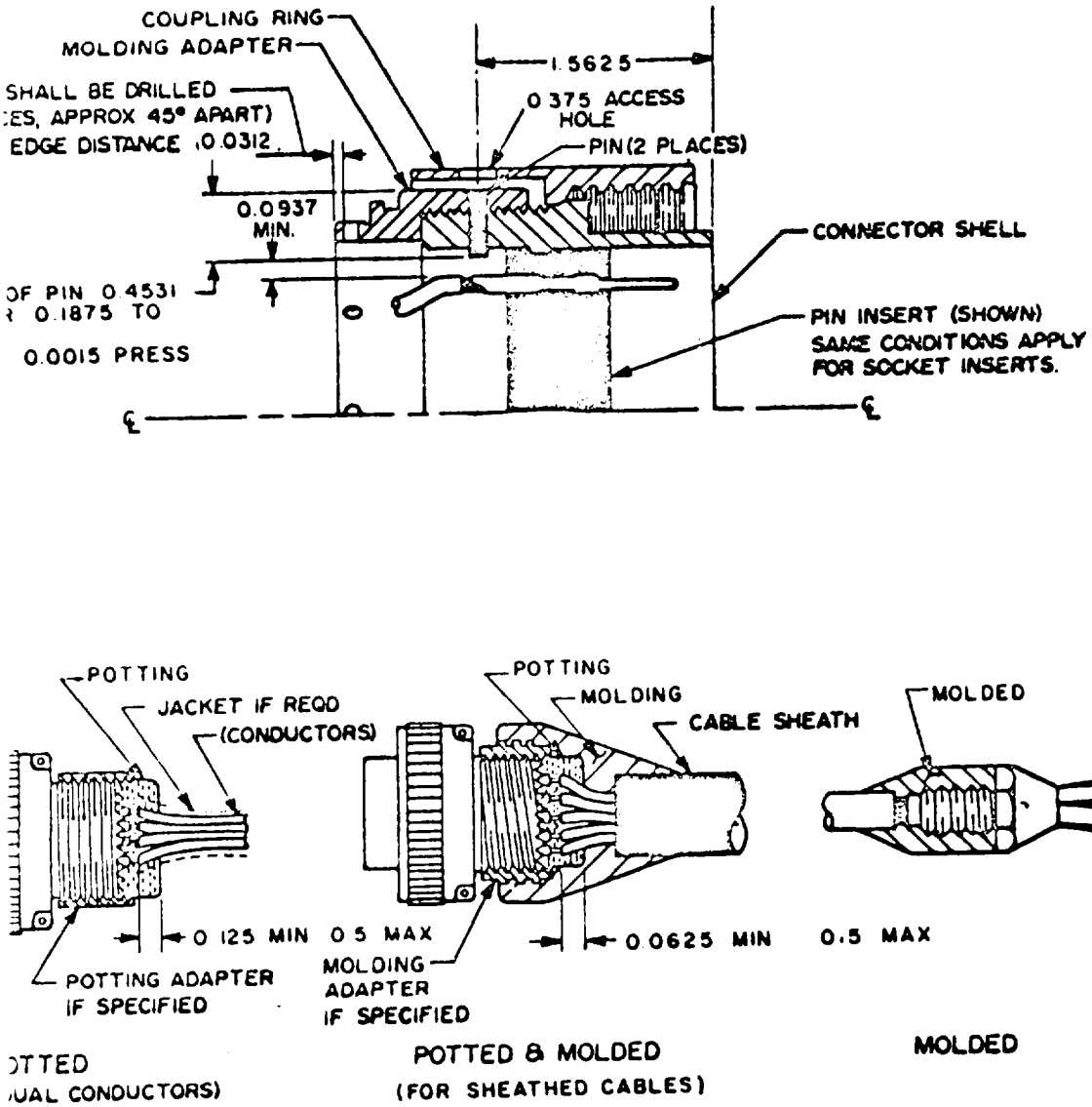
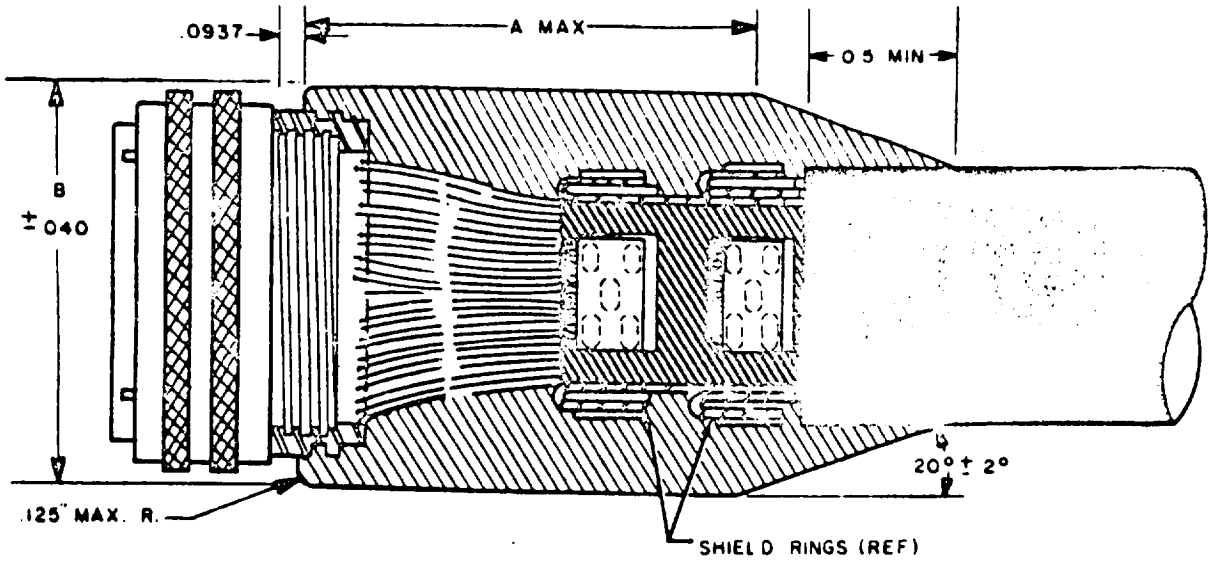
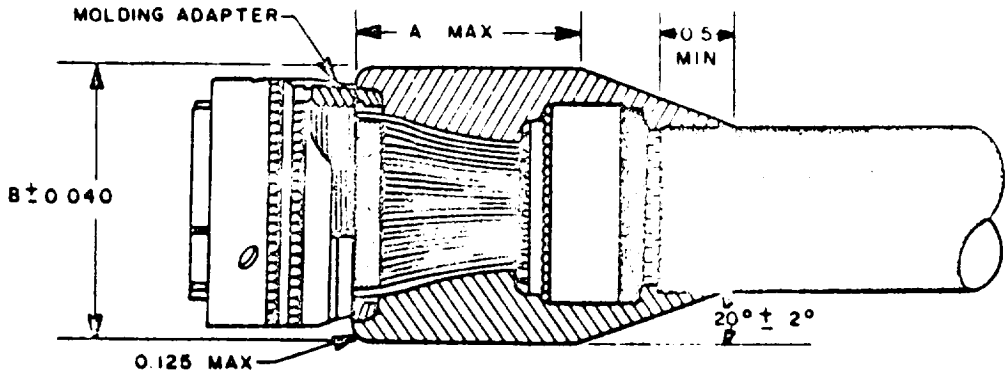


Figure 1. Definition of potting and molding terms.



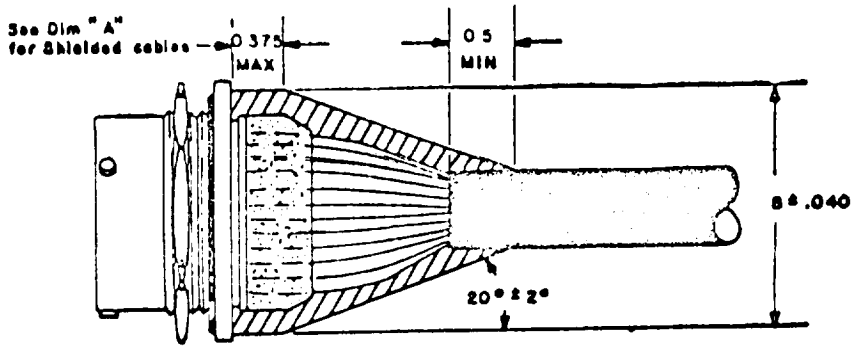
MINIATURE QUICK DISCONNECT CABLE PLUG, DOUBLE SHIELDED



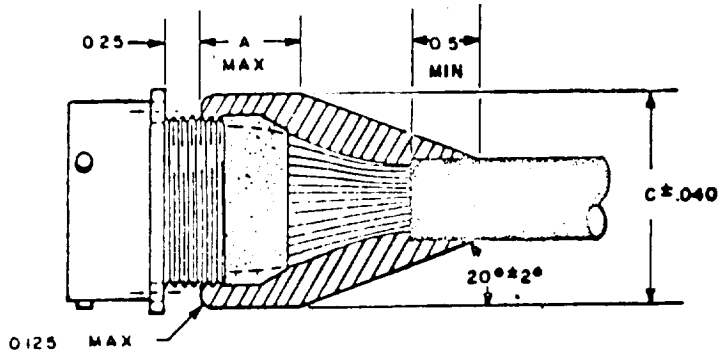
MINIATURE QUICK-DISCONNECT PLUG, SINGLE SHIELDED

--- SEE NEXT SHEET FOR DIMENSION TABLE

Figure 2. Miniature quick-disconnect connectors.



MINIATURE QUICK-DISCONNECT JAM NUT RECEPTACLE TYPE



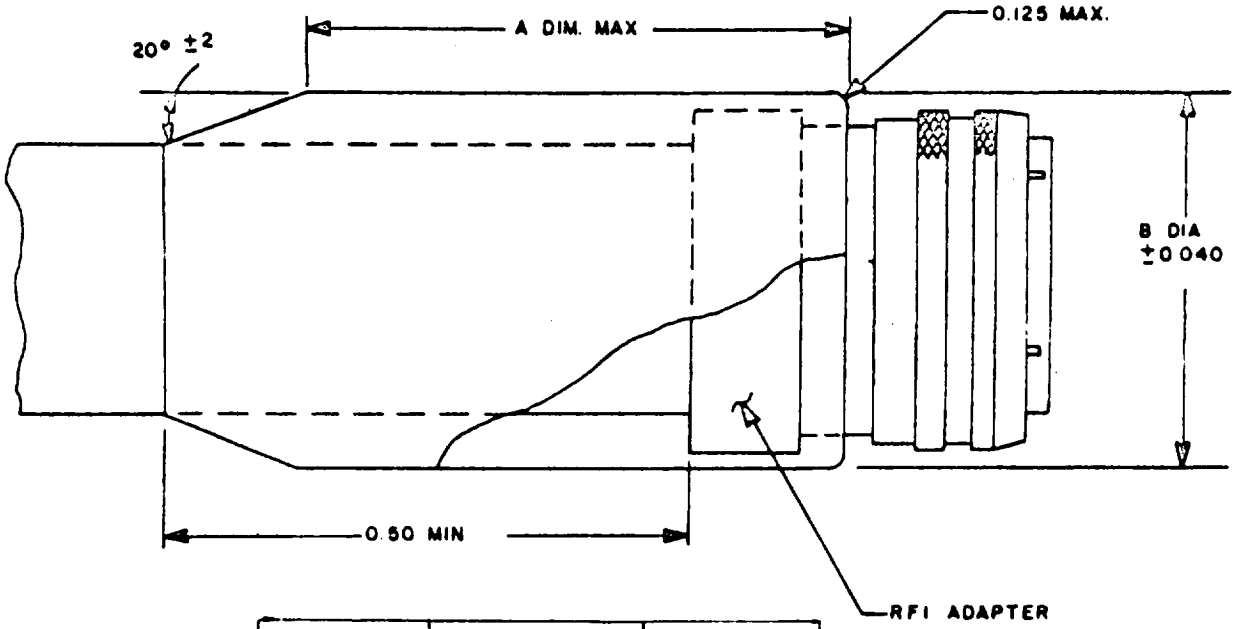
(MOLD ONLY CONNECTORS WITH SHEATHED CABLES UNLESS OTHERWISE SPECIFIED)

MINIATURE QUICK-DISCONNECT WALL MOUNTING TYPE RECEPTACLE (SHOWN)

MINIATURE QUICK-DISCONNECT BOX MOUNTING TYPE RECEPTACLE (NOT THREADED)

SHELL SIZES		6	8	10	12	14	16	18	20	22	24
UNSHIELDED	A DIM	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	B DIM	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625	1.750	1.875
	C DIM	.500	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
SINGLE SHIELDED	A DIM	1.500	1.500	1.500	1.500	1.500	1.625	1.750	2.000	2.250	2.500
	B DIM	SAME SIZE AS FOR UNSHIELDED CABLES									
	C DIM	SAME SIZE AS FOR UNSHIELDED CABLES									
DOUBLE SHIELDED	A DIM	1.500	1.625	1.750	1.875	2.000	2.125	2.250	2.500	2.750	3.000
	B DIM	SAME SIZE AS FOR UNSHIELDED CABLES									
	C DIM	SAME SIZE AS FOR UNSHIELDED CABLES									

Figure 2. Miniature quick-disconnect connectors (continued).



CONN SHELL SIZE	"A"	"B" DIA.
8	1.40	1.000
12	1.40	1.375
14	1.50	1.375
24	2.50	1.750

Figure 3. Shield/Shield adapter.

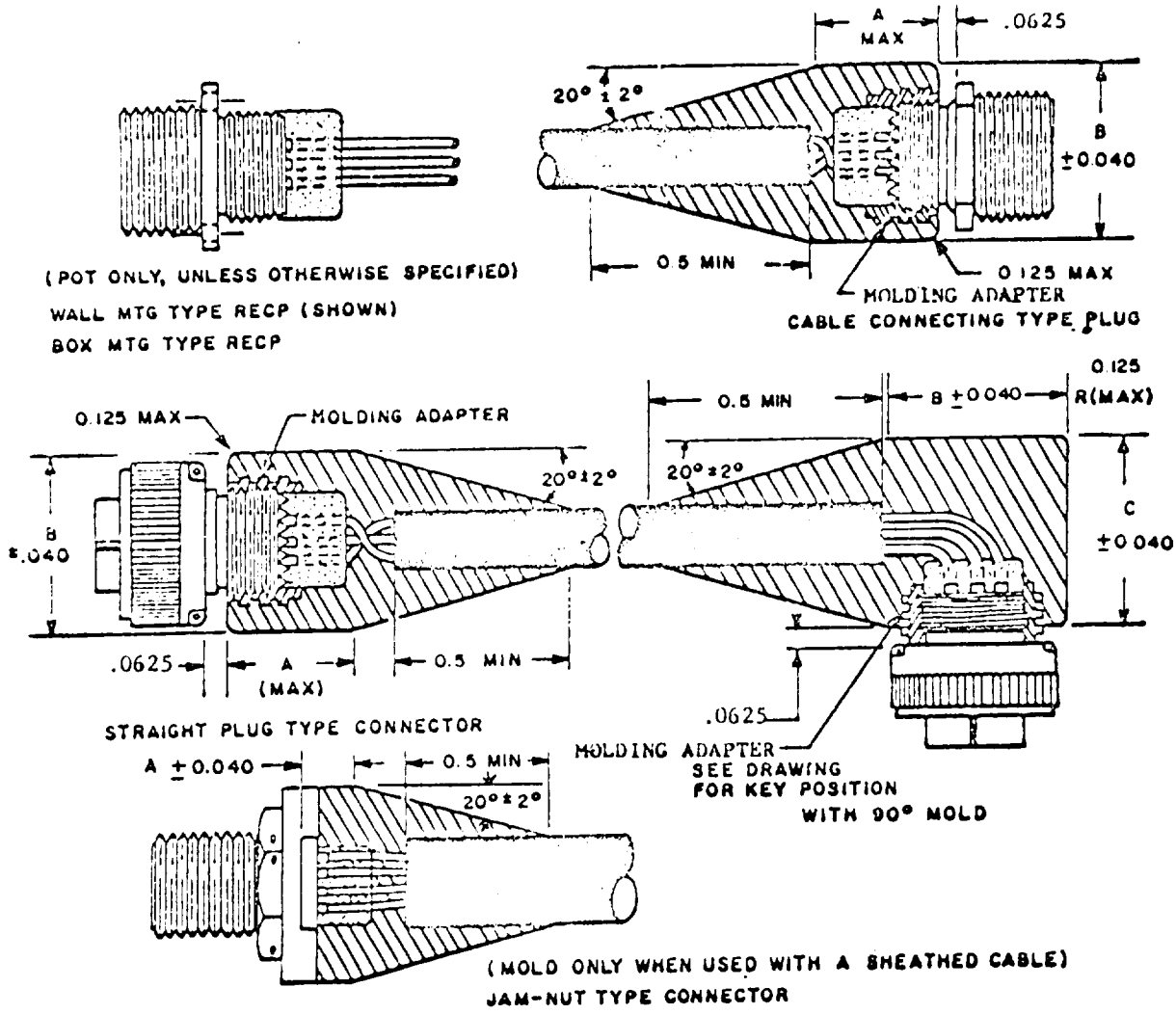
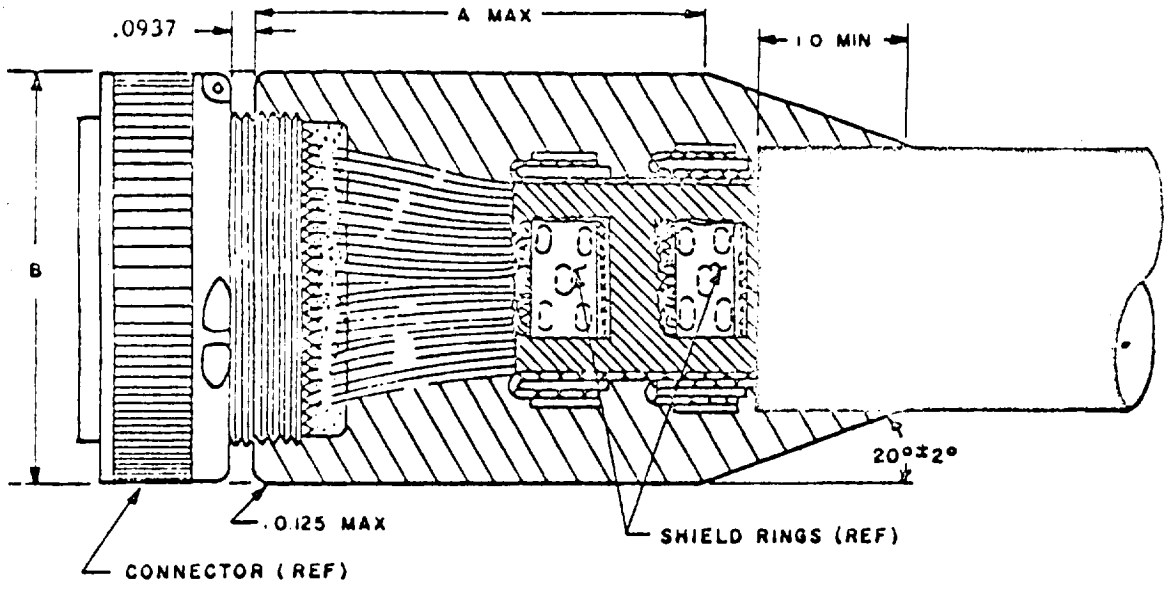


Figure 4. General purpose connectors.

Shell size	"A" DIM (unshielded)	"A" DIM (shielded)	"B" DIM (any)	"C" DIM (any)
10SL	0.625	1.000	1.125	1.125
12S	0.625	1.000	1.187	1.187
14S	0.625	1.000	1.312	1.312
16S	0.625	1.000	1.437	1.437
18	1.125	1.250	1.562	1.562
20	1.250	1.375	1.750	1.750
22	1.250	1.500	1.812	1.812
24	1.375	1.625	2.000	2.000
28	1.500	1.875	2.250	2.250
32	1.500	2.000	2.500	2.500
36	1.500	2.250	2.750	2.750

Figure 4. General purpose connectors (continued).



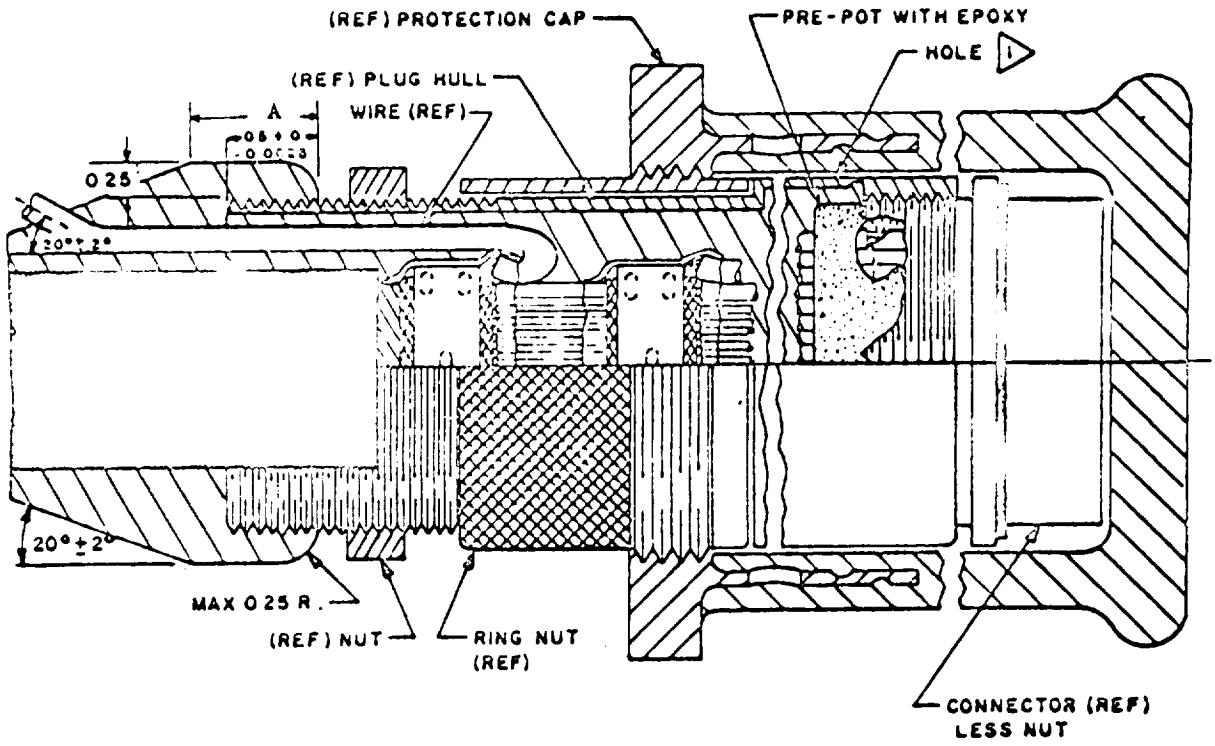
CABLE TYPES

DIMENSIONS	UNSHIELDED	ONE SHIELD RING	TWO SHIELD RINGS
A	2.000	3.000	3.000
B	2.750	2.750	2.750

NOTES:

1. LOCATION OF SHIELD RINGS IS APPROXIMATE AND SHOW ONLY A TYPICAL CASE.

Figure 5. 40 Shell size special general purpose connector.

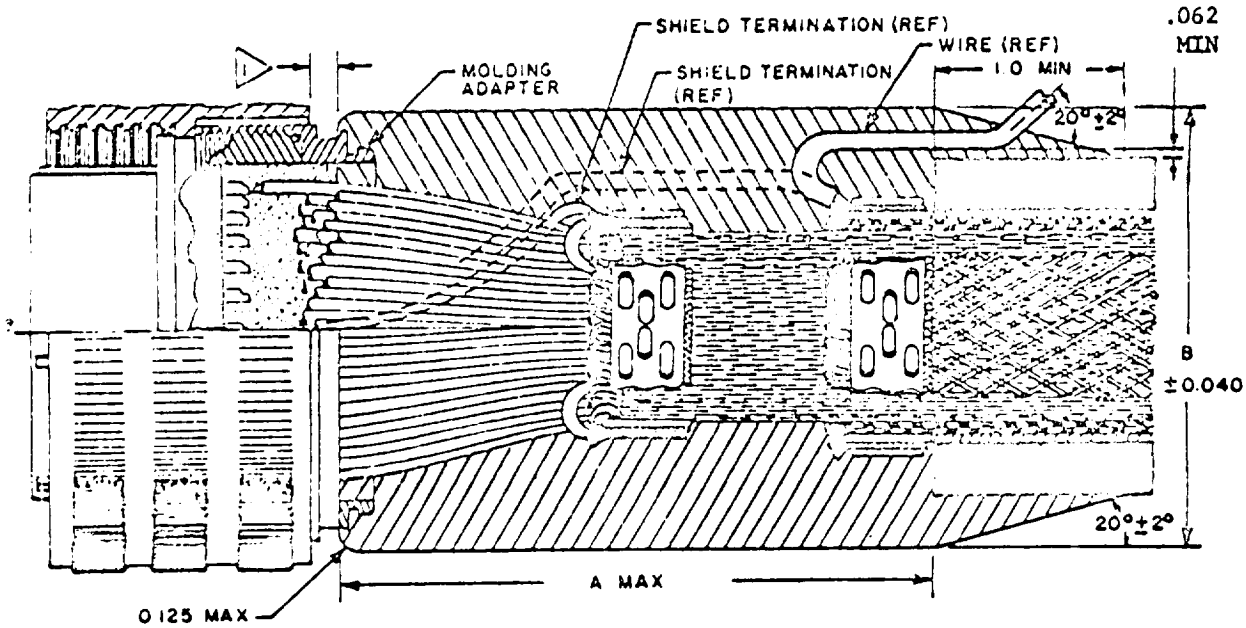


CABLE DIA	DIM A
UP TO 1.60	.75 TO 1.62
OVER 1.60	1.50 TO 1.62

NOTES:

1. INJECT POLYURETHANE INTO HOLE UNTIL IT APPEARS AT THE CABLE ENTRY. THEN MOLD AS SHOWN.
2. LOCATION OF SHIELD RINGS ARE APPROXIMATE AND SHOW ONLY A TYPICAL CASE.
3. ABLATIVE COATING AND/OR SHEATH MAY BE STRIPPED OR GROOVED AS NECESSARY TO ACCOMMODATE GROUND LEAD.

Figure 6. Umbilical connector.



HEAVY DUTY STRAIGHT PLUG CONNECTOR

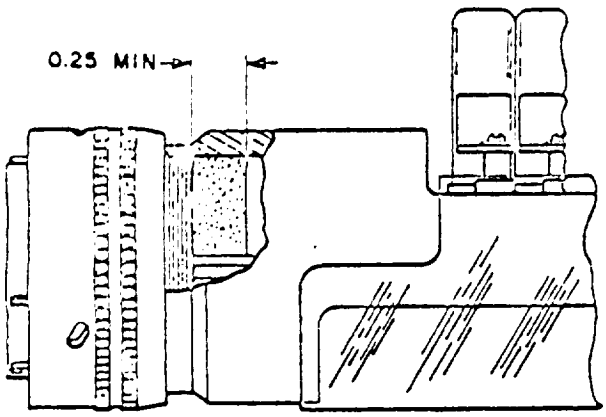
NOTES:

1. WHEN MOLDING HEAVY DUTY FLANGE MOUNT RECEPTABLES, ETC. CONNECTORS (WHERE REQUIRED) NO MOLDING SLEEVE IS REQUIRED, BUT THIS DIMENSION MUST BE HELD TO 0.1875 INCH MINIMUM.
2. LOCATION OF SHIELD RINGS ARE APPROXIMATE AND SHOW ONLY A TYPICAL CASE.
3. JAM-NUT RECEPTABLES WITH NO THREADS ON THE REAR OF THE CONNECTOR SHALL BE MOLDED SIMILAR TO THE BFR TYPE CONNECTORS.

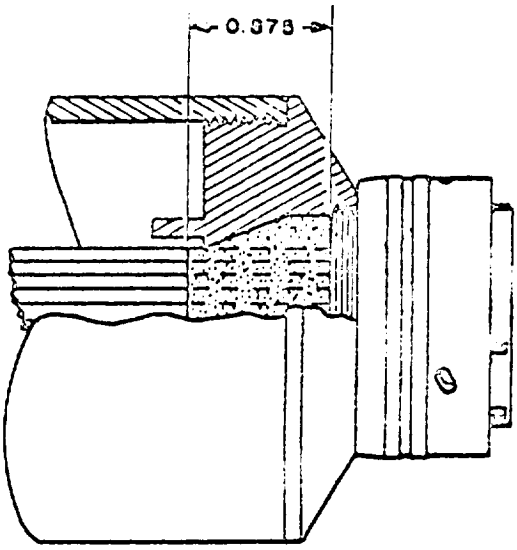
Figure 7. Heavy duty connectors.

Shell size	"A" DIM unsh	"A" DIM 1 shld ring	"A" DIM 2 shld rings	"B" DIM
10	1.000	2.000	2.500	1.250
12	1.000	2.000	2.500	1.250
13	1.000	2.000	2.500	1.250
14	1.000	2.000	2.500	1.250
15	1.000	2.000	2.500	1.500
16	1.000	2.000	2.500	1.500
17	1.000	2.000	2.500	1.500
18	1.250	2.000	2.500	1.500
20	1.250	2.500	3.000	1.750
22	1.500	2.500	3.000	2.000
24	1.500	2.500	3.000	2.250
28	1.750	3.000	3.500	2.375
32	2.000	3.000	3.500	2.500
36	2.000	3.000	3.500	2.750
40	2.000	3.500	4.000	3.000
44	2.000	3.500	4.000	3.250

Figure 7. Heavy duty connectors (continued).



RELAY MODULE (POT ONLY)



DIODE MODULE (POT ONLY)

NOTES:

1. TAKE CARE NOT TO BIND THE COUPLING NUTS.
2. DO NOT SEAL THE REMOVABLE COVER OF THE DIODE MODULE

Figure 8. Module connectors.